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is most to be thanked for the evolution of the bed of an existing river? Something like this I understand to be Messrs. Dewey's and Schiller's contention about 'truth.' The subjective and objective factors of any presently functioning body of it are lost in the night of time and indistinguishable. Only the way in which we see a new truth develop shows us that, by analogy, subjective factors must always have been active. Subjective factors thus are potent, and their effects remain. They are in *some* degree creative, then; and this carries with it, it seems to me, the admissibility of the entire Italian pragmatistic program. But, be the God-Man part of it sound or foolish, the Italian pragmatists are an extraordinarily well-informed and gifted, and above all an extraordinarily free and spirited and unpedantic, group of writers.

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THE DETECTION OF COLOR-BLINDNESS[1]

AT the recent Cambridge meeting of the American Psychological Association, in the course of a discussion of color vision and especially of color-blindness, one of the speakers made the claim that a person deficient in color sense could be trained in a short time so that he could pass successfully the Holmgren test for color-blindness, which in some form or other is the one usually employed where it is practically important to determine defective color vision. If this is the case, and there are numerous evidences in the literature of color-blindness substantiating the claim, then it would seem to be desirable and important to discover a test which can be applied at once expeditiously and with greater certainty of detection. Forty or more tests of a scientific or practical character have been devised. All of these methods are based on the naming or matching of colors, the confusion of colors being in fact the basis of all of them.

Professor Cattell, in various discussions of the time of perception as a measure of differences in sensations, has suggested the value of this method in determining sense deficiencies. So far as I know, no application of the method to testing color vision has been made except in the experiments and results to be reported here. They form part of a general investigation into the application of this method to the measurement of differences in sensations.[2]

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[1] Paper read at the Princeton meeting of the Section of Anthropology and Psychology of the New York Academy of Sciences, in conjunction with the New York Section of the American Psychological Association.

[2] To be published shortly in the *Archives of Philosophy, Psychology and Scientific Methods.*

It may well happen that a color-blind person may be able to pass the Holmgren test or some other naming or matching test without confusion of colors and also without showing such hesitancy that it would be safe to conclude from it that there is a defective color sense. If, however, the one tested is red-green blind, it will take him a longer time to distinguish the reds and greens than the blues and yellows, and, on the other hand, if he is blue-yellow blind, the reverse will be the case. The person of normal color vision, as experiments have shown, takes about as long to distinguish one pair of colors as the other. If, then, we have a measure of the time of perceiving differences between each of these pairs of colors, we have an indication of the nature of the color sense. Should the time be markedly longer for one pair than for the other, it is almost certain that there is defective color vision or color-blindness. As a matter of fact, a test based on the time of perception would seem to approach more nearly the actual conditions to be met where it is necessary for practical reasons to determine defects than methods based merely on the inability to distinguish colors.

In the application of the method it is possible by the use of colored lights or the lanterns actually found in the railway service to simulate these conditions exactly. The time required for this mode of procedure makes the application cumbersome. As is well known, it is necessary to use a variety of reds and greens, for the hues, tints or shades that are confused or are difficult to distinguish vary widely in color-blind persons. The following method used in this study seemed to be entirely satisfactory. One hundred and thirty-two cards were prepared, on sixty-six of which were mounted three blues and three yellows in equal numbers, and on the remainder, three reds and three greens. The colored surfaces, the Milton-Bradley papers being used, were 3 cm. square. With pigments it would be possible to secure greater purity in color-tone and one could define the relations of the colors more exactly. Such surfaces are, however, difficult to prepare and some of the pigments quickly rub off in handling. In each color the Milton-Bradley standard together with one tint and one shade was used. These were selected so that the person of normal color vision could distinguish them as rapidly as he could distribute the cards. Numerous tests on such persons showed that for them the times of distribution were almost exactly equal. A second set of reds was also prepared, made up of the Milton-Bradley orange-red series. The method of giving the test was to place before the subject one each of the blues and yellows, or of the reds and greens, arranged in a fixed order. The time required to distribute the sixty cards, first the blues and yellows and then the reds and greens, and so on alternately, was taken with a stop-watch. A fixed order was adopted to prevent interference in associations, which would have lengthened the time without giving any new information as to color vision. Alternation provides for equalizing practise effects in distribution.

Experiments were made on five color-blind persons, ranging in degree of deficiency from what would perhaps be termed a reduced color sense to extreme confusion of the reds and greens. Ten series were taken on each subject with the standard reds and greens and the standard blues and yellows, and five with the orange-reds substituted for the standard reds, except in the case of one subject. There were, thus, 1,800 reactions to color by each of four subjects and 1,200 by one.

The results of the experiments go clearly to show the validity and value of the test. The person of normal color vision, as stated above, takes no longer to distribute the reds and greens than the blues and yellows. The color-blind person takes much longer, approximately 12 seconds, when the time of distribution for the blues and yellows is approximately 40 seconds. More specifically, the averages of the gross differences with the standard red series for the five subjects are 12.2, 13.7, 15.4, 16.6 and 6.1 seconds, respectively, with the average difference for the group 12 seconds. For the orange-red series the differences are 11.7, 13.0, 7.4 and 18.8 seconds, with an average of 12.7 seconds. Expressed in terms of percentage of increase in the times of distribution of the reds and greens over the blues and yellows, the median differences in the first series are 25, 35, 43.5, 21.5 and 10.5 per cent., and for the group 24.5 per cent. In the second, or orange-red, series these values are 33, 42, 24 and 44 per cent., and for the group 33.5 per cent.

On a basis of these results it can be safely said that if a person takes markedly longer to distribute one pair of colors than the other, there is evidence of a reduction in color sense or of color-blindness. With a larger number of cases on individuals of normal color vision and on color-blind persons these limits can be definitely fixed. This will, then, make possible a convenient method of measuring the color sense. It is one of the valuable features of the method that it furnishes a means of measuring rather exactly individual differences in color perception, and not only the fact of color deficiency, but the degree of the deficiency as well. Various tests on persons of supposedly normal color vision show this and give ground for the belief that a reduction in color sense is more common than is usually supposed and that there are all degrees of ability to discriminate colors, ranging from the highest discriminativeness down through the reduced color sense to the extreme forms of color-blindness. It is, I think, mainly held that the color-blind form a separate species marked off from those of normal color vision, but it seems probable that this is not the case, but that the color-blind form rather the lower end of a normal distribution curve.

This method combines the methods based on the confusion of colors with a measure of the time of perception. This becomes apparent when one takes into consideration the errors made. Wherever the differences in time of distribution are small this is due to the errors and confusions in the reds and greens which would disclose a defect. It is important to note, however, that in most of the standard red series no errors occurred, and in practically all the orange-red series there were no errors. Moreover, the colors could be distinguished if sufficient time was taken in order to secure accuracy, for on running over the results of a distribution errors were detected by differences in brightness, and particularly so when the colors were side by side.

The test is of such a character that it can be given rapidly and by any one. If in the first series the time differences do not appear, the test need not be continued. If they do appear, five or more series should give a sufficiently accurate measure for all practical purposes. Improvements in the test can be made by defining the colors more exactly with reference to each other, as suggested above. In order that equal differences for consciousness be obtained throughout, all that it would be necessary to do would be to apply the method of the time of perception. The time of discriminating the standard blue and the standard yellow and the corresponding standard red and green is about equal. We can determine a difference for consciousness between blue and a blue tint which will be equal to the difference between red and a red tint, and so on for all desired combinations. The preparation of such a series of colors would give the conditions for the very best application of this method.

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DISCUSSION

WHY SOLIPSISM IS REJECTED

AFTER Mr. Schiller's recent pithy presentation of some of the dangers with which solipsism confronts the absolute idealist,[1] it may appear superfluous to discuss the general grounds for the rejection of solipsistic hypotheses. There is a further needlessness, ap-

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[1] This JOURNAL, Vol. III., p. 85.